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Laparoscopic Incisional and Ventral Hernia Repair (LIVH): An Evolving Outpatient Technique

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ABSTRACT

Background and Objectives: The contemporary results of open incisional and ventral hernia repair are unsatisfactory because of high recurrence rates and morbidity levels. Laparoscopic repair of ventral and incisional hernias (LIVH) can be accomplished in a simple, reproducible manner while dramatically lowering recurrence rates and morbidity.

Methods: One hundred consecutive patents underwent laparoscopic repair of their ventral and incisional hernias over a 27-month period. Composix mesh and Composix E/X mesh (Davol Inc., Cranston, RI) were utilized for the repairs. Transfixion sutures were not used.

Results: All repairs were completed laparoscopically. No conversions to open techniques were necessary. No postoperative infections have been observed. One recurrent hernia was identified and subsequently repaired with the same technique.

Conclusions: LIVH can be accomplished with a dramatic reduction in recurrence rates and morbidity. The technique for this repair is still in a state of evolution. The construction and handling characteristics of this particular type of mesh have allowed us to eliminate transfixion sutures and to simplify the repair technique while maintaining a very low recurrence rate.

Key Words: Laparoscopic hernioplasty, Ventral hernia, Incisional hernia, Mesh, Prosthetic materials, Adhesions.

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INTRODUCTION

Surgeons have been repairing ventral and incisional hernias by laparoscopic techniques since 1993.[1] Continuous modifications and creative application of new technologies has been the rule. The goal of surgeons has been twofold. First is the reduction of the high recurrence rates seen with traditional open repairs. The second and more humanistic goal has been to reduce the morbidity of the traditional repairs by applying minimally invasive surgical techniques.

Incisional and ventral hernia repair is a commonly performed operation. Unfortunately, it is fraught with high complication rates, extended hospital stays, and an unacceptably high recurrence rate that is underestimated by the very surgeons performing the operation.[2] Since its introduction to the surgical community 8 years ago, the process of repairing ventral/incisional hernias by laparoscopic techniques has consistently demonstrated a remarkable reduction in recurrence rates, hospital stays, and morbidity.

The purpose of this paper is to introduce a technique for laparoscopic repair of ventral/incisional hernias (LIVH) that is less complex and time consuming than previously reported procedures. Like our predecessors, we rely on a wide overlap of a synthetic material intraabdominally to cover the hernia. We have chosen to use Composix Mesh and Composix E/X mesh (Davol Inc., Cranston, RI) for these repairs because the materials utilized in the construction of this mesh allow it to be secured rapidly without the need for transfixion sutures through the abdominal wall. Six years of operative experience repairing a wide variety of hernias with this technique has confirmed our position that it is an easily learned technique. More importantly, it grants all the benefits of laparoscopic surgery to patients with ventral/incisional hernias while maintaining recurrence rates that are superior to recurrence rates of open repairs.

MATERIALS AND METHODS

Three steps are required that must be accomplished if the ventral/incisional hernia is to be repaired in a satisfactory fashion: (1) safe abdominal access with proper

port geometry, (2) complete lysis of intraabdominal adhesions, and (3) introduction and fixation of an appropriately sized piece of mesh.

In many ways, our operative procedure begins in the office. The procedure is described to the patients. They are made to understand that before any mesh is inserted the adhesions must be removed so that anatomy is clearly seen. A full bowel prep (cathartics and antibiotics) is given the evening before surgery to improve the safety of intraoperative bowel handling and adhesiolysis. We also describe the need for a compressive dressing over the hernia sac in the postoperative period. Proper patient compliance with this process can dramatically affect the development of postoperative seromas. A 50% reduction in postoperative seromas has been demonstrated with the use of postoperative abdominal wall pressure dressings.[3] In most cases, our patients are asked to continue the compressive dressing until the first postoperative visit 7 to 10 days postoperatively. They are allowed to remove it for showering.

The procedure is performed with the patient under general anesthesia, and intravenous antibiotics are given in the holding area. In most cases, 1.5 g of ampicillin/sulbactam is given unless patient allergies dictate a change. An orogastric tube is inserted, but a Foley catheter is placed only at the discretion of the surgeon. The patient is placed in a low lithotomy position with both arms outstretched on arm boards. Typically, a towel roll is placed under the patient's flank on the primary surgeon's side. This rolls the patient and target hernia slightly away from the surgeon, which facilitates placement and utilization of the trocars in the lateral abdominal wall. All lines and tubing leave the field at the patient's shoulders so that the surgeon may move freely from the patient's left to right sides or even between the legs if safe dissection requires it.

Initial port strategy is determined by the location of the hernia but may be altered by the degree of adhesiolysis required. In most cases, the entire operation can be accomplished with 3 ports. Typically, a single 10- to 12-mm trocar is inserted in a left subcostal position, and 5-mm ports are placed at the transverse umbilical line and just anterior to the anterior superior iliac spine. In all cases, these ports are lateral to the rectus muscle. The method of initial port-site insertion is left to the surgeon's preference and experience. We prefer nonbladed optical ports (Optivew, Ethicon Endo Surgery, Cincinnati, OH) inserted in an oblique or Z-track fashion. Our personal experience has shown that when properly inserted they are safe and reduce port-site hernias and complications.[4] Additional 5-mm ports are liberally placed as needed to facilitate safe visualization and dissection. Often a fourth 5-mm port placed 180 degrees from the previous ports is all that is required.

The goals of port placement are to maintain proper triangulation for working, and to eliminate camera angles that result in paradoxical motions on the screen. We feel that the ports need to be far enough away from the hernia so that angled scopes are not required to visualize the defect. This strategy allows us to gain maximum utility from our nonreticulating 5-mm instruments and tacker. Over-reliance on angled laparoscopes during a case would suggest that the ports have been inserted too close to the hernia defect.

When epigastric, suprapubic, and flank/lumbar hernias are encountered, the port strategy and patient positioning are adjusted. In these special circumstances, we take full advantage of table tilt, patient positioning, and flexible port placement to accomplish the same port strategy goals mentioned above. Suprapubic hernias often require a limited preperitoneal dissection to push the bladder down and expose the pubic tubercle and Cooper's ligament for mesh fixation. Epigastric hernias typically require a complete takedown of the falciform ligament so that the mesh may extend under the costal margin for added security. We avoid port placement or mesh insertion though the hernia defect itself as any wound complication with such a port could potentially affect or expose the mesh below it.

Once the ports are appropriately placed, the abdominal cavity is evaluated and any required adhesiolysis is accomplished. All hernia contents are reduced, but no effort to remove the sac is undertaken. If the hernia sac contains bowel, the contents are evaluated to ensure that bowel obstructions will not occur from intraloop adhesions now that they have been mobilized and reduced. The instrumentation chosen for adhesiolysis depends on the nature of the findings. Blunt dissection is very useful but well vascularized and dense intraabdominal adhesions are lysed with the curved 5-mm LCS Harmonic Scalpel (Ethicon Endo Surgery, Cincinnati, OH). Its multitasking nature (grasping, dissection, transection, and hemostasis) along with its safety profile relative to monopolar cautery has made it indispensable for many

of these cases.[5-8] When dense intestinal adhesions to prior incisions or mesh make utilization of any energy source hazardous, gentle blunt and sharp dissection with laparoscopic scissors and graspers is used.

Once the edges of the hernia are clearly visible, the defect size is measured internally by insertion of a small flexible plastic ruler or umbilical tape. External measurements overestimate the true size of the fascial defect when the abdomen is insufflated and are likely to promote insertion of a mesh that is far larger than needed. Our goal is to place a prosthesis that extends 3 to 5 cm beyond all edges of the defect. Five cm is the preferred overlap but in some circumstances, such as fixation of the mesh to the pubic tubercle or under the costal margin, smaller overlaps are permitted.

We have made a transition from using the original Composix mesh to the new Composix E/X mesh for our repairs. We have found the expanded polytetrafluoroethylene (ePTFE) surface on the Composix E/X to be more resistant to abrasion during manipulation. The mesh is also thinner than its predecessor, which has advantages during mesh insertion. Once the proper size has been determined, it is inserted via the 10- to 12-mm trocar site. We have found that 18 x 23-cm pieces of mesh can be wound around a 5-mm grasper and inserted through the trocar itself. It is important to roll the mesh so that the ePTFE surface is on the inside and protected from abrasions from the valves in the trocar. Larger pieces of mesh up to and including the 25 x 36-cm piece may be rolled and inserted via the port site after the port is removed. Direct insertion via the abdominal wall trocar incision requires the surgeon to roll the mesh so that the Marlex surface is on the inside. This prevents unnecessary drag/trauma as the mesh is inserted through the layers of the abdominal wall.

The unique incorporation of Marlex on the peritoneal side of this particular mesh has allowed us to eliminate the full thickness abdominal wall sutures required for placement and proper fixation of ePTFE patches. By eliminating this step, the procedure becomes faster and easier to perform. The mesh is secured to the abdominal wall with 5-mm helical tacks. Transabdominal transfixion sutures are not necessary for securing or orienting the mesh. The Marlex backing on the mesh results in excellent handling characteristics, which simplifies orientation and accurate placement. In most cases, it can be held in place against the abdominal wall with a single 5-mm instrument prior to tack placement. It is recommended that the midline of the mesh be oriented with the vertical axis of the hernia prior to placing the tacks. The first tack should be placed at either the caudal or cephalad edge of this vertical axis. The second tack is then placed 180 degrees from the first after a final check of mesh orientation. Drawing a dark line down the vertical axis of the mesh with a sterile marking pen prior to mesh insertion is recommended. When done properly, this technique eliminates the potential for inadequate overlap of the mesh beyond the edges of the hernia. Once the mesh is properly positioned with the first 2 tacks, the mesh is rapidly secured with a row of tacks at the periphery of the mesh. These are placed 1 to 2 cm apart to transfix the mesh and to prevent bowel or omentum from slipping under the edge. A second inner row of tacks is placed at the edge of the hernia defect itself with bimanual palpation (hand outside/tacker inside) to ensure proper placement.

RESULTS

One hundred consecutive patients have undergone laparoscopic repair of their ventral and incisional hernias with the techniques described above over a 27-month period. Most were elective surgeries; however, 4 cases of incarceration and obstruction were included. Three enterotomies (2 small bowel, 1 right colon) occurred in the elective surgical group during blunt or sharp dissection. In each case, no contamination occurred, the bowel was repaired laparoscopically in 2 layers, and mesh was inserted without complication. No injuries occurred related to the use of the Harmonic Scalpel or the nonbladed Optiview trocars.

The complexity of the cases has varied widely as has the size of the defects repaired. Mesh inserted for repair has varied in size from 10 x 15 cm to 25 x 36 cm. Initially, Composix mesh with 2 layers of Marlex (Davol Inc., Cranston, RI) fused to 1 layer of ePTFE was used for the repairs. Since the introduction of Composix E/X, we no longer use the original mesh. The current mesh has 1 layer of Marlex sewn to a thicker layer of ePTFE. Consequently, the ePTFE surface is more resistant to abrasion during placement, and larger pieces can be inserted via the trocar.

One recurrence has been discovered during the follow-up period. Clinically significant seromas have been rare. Only 3 have required drainage. No port site or wound

infections have occurred. To date, no postoperative bowel obstructions or readmissions for pain control or ileus have been necessary. One morbidly obese patient required urgent exploration and drainage of a large subcutaneous and intramuscular flank hematoma resulting from the use of a bladed 5-mm trocar. No deaths have occurred.

DISCUSSION

In the last 6 years, we have gained a great deal of practical experience with LIVH repair by caring for our own patients and through teaching other surgeons. We have learned that the most important details relate to (1) proper port geometry, (2) safe adhesiolysis, and (3) inserting an appropriately sized mesh to maintain adequate overlap beyond the margins of the hernia.

The single hernia recurrence in this series has subsequently undergone laparoscopic evaluation and repair. The initial repair involved multiple widely spaced hernias covered with a single large 25 x 36-cm prosthesis. On reexploration, it was obvious that the original repair was still intact and well incorporated. The recurrence was small but had occurred at the edge of the mesh closest to the working ports. Inadequate prosthetic overlap on the near side was the likely cause of this preventable recurrence.

Incisional hernias remain a problem in many surgical specialties despite improvements in materials and adoption of methods like the mass closure technique. Aside from obesity and wound infection, the explanation for the occurrence of these hernias has been difficult to find. It has been estimated that close to 10% of incisions will develop hernias.[2,3] A review of 655 patients whose incisions were closed with a running monofilament utilizing a mass suturing technique revealed an incisional herniation rate of 14.2% by 2 years, with 8.4% presenting in the first year.[9] In general, 60% to 90% of incisional hernias are observed in the first 2 to 3 years after major laparotomies.[10,11]

Repair of incisional and ventral hernias is a commonly performed operation. Unfortunately, the recurrence rates associated with traditional open repairs are unacceptably high. A modern trial of 200 patients undergoing suture or mesh repair of a primary hernia or a first recurrence reported a 3-year recurrence rate for primary hernia repair of 43% in the suture group and 24% in the mesh group. These recurrence rates climbed to 58% when suture alone was used to close recurrent hernias. They noted that the size of the hernia did not affect the rate of recurrence and that mesh repair (retrofascial preperitoneal polypropylene) was superior to suture repair alone.[12] The traditional Vertical Mayo or "Vest-Over-Pants" repair has been shown to have a 48% recurrence rate in the first 3 years when used to repair midline incisional hernias.[13] Historically, primary tissue repairs have been associated with a 30% to 50% recurrence rate. Although the adoption of tension-free repair techniques with mesh prostheses has dropped the recurrence rates to the 10% to 20% range, it is still unacceptably high.[14,15]

Wound complications accompanying open mesh repairs of ventral/incisional hernias are widely described. One series of 250 hernias repaired over 14 years yielded a wound complication rate of 34%. The complications being reported were infection, seroma formation, hematoma, and fistula formation. Those patients in whom mesh was used during their repair suffered a wound complication rate of 49% and an infection rate of 18%.[16] In 1987, Stoppa reported an infection rate of 18.5% in his series of 230 retrorectus mesh repairs.[17] More recently, open repairs with ePTFE have demonstrated infection rates of 7.1% to 9.6%.[18,19] The use of prosthetic materials in open ventral hernia repairs reduces the risk of recurrent hernias but carries the risk of increasing wound infections. It is not unreasonable to presume that the large amount of dissection and tissue undermining/devascularization required to accomplish these repairs has contributed to the infection rate. The pain associated with the dissection and mesh fixation certainly plays a role in the need to admit many of these patients to the hospital postoperatively.

LIVH repair has demonstrated lower complication and recurrence rates relative to traditional open techniques. The improved results have been maintained despite variations in technique and prosthetics from study to study **(Table 1)**.[20-28] The common denominator in all successful LIVH repairs is the intraperitoneal placement of the prosthesis. In general, the only things that have changed from one study to the next are the types of prostheses being inserted, the degree of hernia overlap, and the manner of fixation.

The economics behind LIVH repair may also be advantageous. We have previously demonstrated that more than 95% of these patients can be discharged from the recovery room regardless of the size of the defect.[29]

Table 1.
Infection and Recurrence Rates in LIVH Repair

Researcher	Year	No. of Patients	Follow up	Mesh	Infection Rate %	Recurrence Rate %
Park[20]	1996	30	>18 m	PTFE	3.3	3.3
Franklin[21]	1998	176	1-84 m	Polypropylene	1.7	1.1
Costanza[22]	1998	31	18 m avg	PTFE	6.5	3.2
Park[23]	1998	56	24.1 m avg	PTFE/ Polypropylene	0.0	10.7*
Toy[24]	1998	135	222 days avg	PTFE	3.7	4.4
Kyzer[25]	1999	53	Unavailable	PTFE	1.8	1.8
Ramshaw[26]	1999	79	21 m avg	PTFE	2.5	2.5
Reitter[27]	2000	42	27 m	PTFE	2.3	7.1
Heniford[11]	2000	407	23 m	PTFE	2.2	3.4
Gillian[28]	2000	96	1-60 m	Composix	0.0	2.0
Chowbey[3]	2000	202	2.9 yrs	Polypropylene	2.5	1.0

*Only 2.5-cm overlap used.

Others have demonstrated a significant decrease in facility costs when comparing open and laparoscopic repairs as 90% of their laparoscopic hernia repairs did not require inpatient care.[30] Shorter hospital stays and less severe postoperative complications in laparoscopic repairs contributed to statistically significant lower costs relative to open repairs in the same study.[31] A group of surgeons cut their hernia recurrence rate by nearly 50% when they switched from open placement of ePTFE to laparoscopic placement. They declared the decrease in postoperative pain, complications, and lowered recurrence rate to be a "great benefit to our practice."[27]

It is difficult to accurately catalogue the various laparoscopic techniques that have been tried in an effort to reduce recurrence rates and complications associated with traditional anterior repairs. They are often simply a reflection of the technology available at that particular time and the skill of the surgeon involved. Some aspects of the repairs such as patient preparation, trocar placement, and lysis of adhesions change very little from report to report. The area that has varied widely is related to mesh-specific fixation needs.

Early attempts at laparoscopic ventral hernia repair were often a reflection of what was being taught for inguinal hernia repair. Preperitoneal dissections were made and polypropylene mesh was placed over the defect and stapled to the abdominal wall. The peritoneum was then closed to prevent mesh from contacting the bowel.[32] A preperitoneal dissection near a ventral/incisional hernia can be quite difficult. Some have referred to it as being "virtually prohibitive."[31] As a result, methods for complete intraabdominal mesh placement have been evaluated.

Although surgeons were familiar with polypropylene mesh from open hernia repairs, many were worried about the complications that could develop from a complete intraabdominal placement of this material. In some techniques, the omentum is used to act as a barrier between the polypropylene and the bowel.[33] In fact, many authors began to use ePTFE in their repairs despite its much higher cost. They felt that the possible reduction in both intraabdominal adhesions and the risk of bowel fistualization justified the cost of the ePTFE.[23,25,33] Despite these concerns, some surgeons have produced large series of patients repaired with polypropylene that

have excellent results and no evidence of complications related to bowel adherence to the mesh.[3,21]

Despite advantages in terms of intraabdominal adhesion formation, ePTFE presented its own unique set of challenges for surgeons. Very experienced laparoscopic surgeons have described manipulation of this mesh as "a cumbersome procedure"[20] and "difficult to work with laparoscopically because of its lack of memory and the fact that it is opaque."[11] Surgeons also began to realize that hernia staplers were inadequate to transfix this material to the abdominal wall and began looking for alternatives.[34] In 1996, Dr. Park noted that "none of the currently available articulating endoscopic staplers consistently and adequately secured a 1-mm PTFE patch to a depth beyond the peritoneum." He and others began to increase the length of their overlap to 3 cm or greater and to utilize full thickness transabdominal stay sutures to secure the mesh.[20,35,36] These measures also serve to compensate for the relative lack of fibrous ingrowth into the PTFE relative to polypropylene. PTFE repairs rely heavily on the integrity of the suture attachment of the prosthesis to the fascia.[37] Failure to place these full-thickness sutures in PTFE repairs results in higher recurrence rates.[11]

When ePTFE is properly sized and transfixed, excellent results can be achieved with laparoscopic ventral hernia repairs **(Table 1)**. Unfortunately, some of the mesh-specific needs of ePTFE can make these repairs difficult for surgeons who do not have a great deal of experience with the technique. In some cases, the proper placement and orientation of the sutures can add up to 50% to the time needed for repair.[38] These sutures represent a potential portal for contamination of the mesh with skin flora, risking infection and possible mesh removal.[24,36] Reports have also been made of long-term pain associated with the sutures, and in some cases second procedures have been necessary to remove the offending suture.[11,27,36]

We have found Composix mesh and now Composix E/X mesh to be excellent prostheses for the laparoscopic repair of ventral and incisional hernias. Their ePTFE surface protects the visceral organs from significant adhesions while the polypropylene surface provides a dependable template for rapid fibroblastic ingrowth.[39] Additionally, the polypropylene layer gives the mesh enough memory to make it easy to manipulate both small and large pieces in a laparoscopic field. The problems related to transfixion sutures are simply avoided, as they are unnecessary. We feel the technique we have described for LIVH repair is one that can be easily replicated by most general surgeons without the need for advanced training in laparoscopic surgery.

CONCLUSIONS

Surgical technique for repair of hernias is as old as the profession itself. Over time, the accepted gold standards for repair of specific subsets of hernias have been challenged and often replaced. The stimulus for the reevaluation of 'standard' techniques is often the result of technical innovation and the availability of novel materials. Until the recurrence rate reaches zero and pain is eliminated from the process of hernia repair, we will continue to strive to do better.

The contemporary results of open incisional and ventral hernia repair are unsatisfactory because of high recurrence rates and morbidity levels. The minimally invasive approach to repairing even complex ventral and incisional hernias is gaining rapid acceptance across the country due to its lower recurrence rate, reduced complication rates, and patient satisfaction. The location for laparoscopic repair of these hernias is quickly moving from the large academic centers to community hospitals as surgeons educate themselves on newer, less awkward techniques for mesh insertion and fixation. A "gold standard" for laparoscopic ventral and incisional hernia is difficult to develop when the products being used change so rapidly. To our advantage, newer-generation products (ie, nonbladed optical trocars, ultrasonic shears, smaller tackers, and improved mesh composites) are making these repairs safer for patients and easier to learn for surgeons who do not have the benefit of advanced laparoscopic training. Currently, no single company has all the components required to fix these defects. Consequently, surgeons must keep an open mind about all of the products and techniques being offered to facilitate the repair now and in the future.

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